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ABSTRACT

The issue of problem awareness and problem definition is discussed in this occasional paper. It is proposed that a problem can be defined as one of four instances of indeterminancy: anomaly, unverified fact, uncharted area, or conflicting evidence; further, for each of these categories, three levels of problems are seen to exist: (1) what variables are involved; (2) what is their nature; and (3) what are their cause/effect relationships. Three techniques are explained for delineating problems: the integrative theonomy, facet analysis and design, and componential analysis. It is suggested that these delineation techniques have two applications in the training of researchers: (1) as content, which might be taught to the researcher-to-be, and (2) as tools to examine the area of research instruction. (MJB)

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OCCASIONAL PAPER

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THE PROBLEM AND PROBLEM DELINEATION TECHNIQUES

by

William J. Gephart
Phi Delta Kappa

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THE PROBLEM AND PROBLEM DELINEATION TECHNIQUES

by

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In a very real sense the "problem" is the major problem in research. In just as real a sense the term is our problem as we focus on the means of improving instruction about the research process. This paper will take up first the definition of the terms, second a description of several techniques for the delineation of problems, and finally a discussion of the application of these techniques to the "problem" of the training of educational researchers.

WHAT DOES "PROBLEM" MEAN?

Literature on the research process is in agreement that the work of the educational researcher should be based on a carefully analyzed problem. Travers states, "The fact is that the major effort in the undertaking of research should be devoted to the planning stage, which may include not only a careful formulation of the problem....but also some preliminary data-collecting activities." (Travers, 1964). Similar statements can be found in almost every text on the research process.

When it comes to helping the student understand what is meant by that term, "problem," this body of literature is not very helpful. Instructional approaches include: (1) the delineation of areas in which problems exist; (2) the listing of titles of completed research as examples of problems; and (3) a few attempts at defining the term.

The first of these approaches is exemplified in Travers' book. He presents four broad areas. Such an approach does not assist either in the definition of the term, "problem," or in the identification of specific problems. Rather, it makes clear the locus, the place within which problems exist.

The second approach is exemplified by several authors. They string out lengthy lists of titles and assume that by careful examination of those titles the student will understand the meaning of the term, "problem." The difficulty in this approach results from two things. First, titles are terribly misleading. It is not at all uncommon for a title and the content of a report to be distinctly different. Second, the list of titles contains individual items that are so diverse that even the very perceptive student is unable to extract their commonality which makes them acceptable as problems.

The third attempt has so much impreciseness of language as to be almost impossible. For example, Van Dalen says, "John Dewey answered the question (what is a problem) by suggesting that a problem arises out of a felt-difficulty." (Van Dalen, 1962) Such an instance does not always identify what is commonly referred to when we speak of a research problem. In many instances the felt-difficulty is a sympton of a problem, while in others the felt-difficulty exemplifies an area of knowledge not yet mastered by the individual who possesses the feeling. The texts that use this approach very quickly disarm the student by cautioning him that any old "felt-difficulty" will not suffice. Certainly it cannot be a felt-difficulty that has been investigated by someone else and just as certainly it must be a *significant* "felt-difficulty." The failure for these authors to reach clarity on the distinction between significance and insignificance hurts students' understanding of the term.

One text (which will remain anonymous since its author is revising it) devotes ten pages to explicating the topic, the research problem. The first half of this spread discusses the sorry plight we are in. Problems abound. We have but to open our eyes to identify them. But the graduate student seems incapable of

problem awareness. Elaborate discussion of the commonness of problem myopia does not help in overcoming the disease! In fact it may provide a security of numbers that is, to my way of thinking, harmful to progress. The student can reason: I do not have the skill to identify a problem; the vast majority are like me; all of us cannot be flunked. Therefore, why struggle to learn what is meant by the term?

This same text proceeds to indicate that the student is and *should be* on his own in this area. The research effort is a test of his mettle and the wiser heads ought not to meddle! I could not disagree with an idea more strongly than I do with that. The evidence (the number of poorly delineated problems in graduate program research requirements) is overwhelming proof that we do not fail people on the basis of poor performance. Further, my value system holds that a student has the right to expect help in learning about an area. I believe it unethical to say in effect, "You are on your own." He is in a learning situation. And he has bought (or at least paid for) help. Our refusal to provide the needed help is a cover we use to avoid examination of our own inadequacy. Professors in general do not know to identify and define research problems. Again, the evidence is strong. (Smith, 1964). Over half of the research proposals Smith studied were labeled inadequate due to the nature of the problem statement.

In concluding this intemperate notation of our problems in teaching the concept, "problem," I seek your reaction to three assertions. Professors of educational research must help students understand what is meant by the term "problem" and how to identify and delineate them. Definitional studies must be initiated to clarify the meaning of the term, "problem." Once the term is defined, empirical tests of approaches for teaching it must be conducted.

Three instances in the literature seem helpful in movement toward a definition of "problem." Two of those instances present a common list.

1. He (the researcher) lacks the means to get the end desired.

2. He has difficulty in identifying the character of an object.
3. He cannot explain a.. unexpected event.

The third statement is somewhat similar. It was made by Clark, Guba and Smith (Clark, Guba, Smith, 1962) in an outline for a text which unfortunately has never been completed. They suggest the existence of four types of problems: an anomaly, an uncharted area, a situation involving conflicting evidence, or an instance of unverified fact. An anomaly can be exemplified by the following: Imagine yourself walking along the Artic Circle. As you reach the crest of a snow bank you see a palm tree growing out of the ice. The facts we know at this point fail to explain that observation. An anomaly in the Guba, Clark, Smith list equates to the third item in the list above, inability to explain an unexpected event.

The uncharted area of category of problem equates to item two in the list above, difficulty in identifying the character of an object. In both instances there seem to be avenues which have not been explored.

Category three, the conflicting evidence problem, is not found in the other list. There are many such instances in the field of education. Reading perhaps provides a ready focus. For years some reports of research have indicated that Method A is more effective in teaching reading than Method B. Simultaneously, other reports state the opposite. Because of the conflict between the conclusions, a problem still exists. Parenthetically, it seems that in such instances two possibilities exist: Either the research methodology is inadequate or variables other than those investigated seem to exert greater influence on the criterion.

The final category, unverified fact, also is rife in education. Handwriting provides a case in point. Schools, for the most part, start children writing with manuscript printing. At approximately the third grade a conversion is made to cursive writing. John Carroll has indicated that no empirical evidence can be found which would substantiate either that that sequence is appropriate or that the timing within the sequence is valid (Carroll, 1961).

The three items in the list above and the four items in the Clark, Guba, Smith presentation are all instances of indeterminacy. That is, sufficient knowledge does not exist to answer questions about them. On this basis, it would be appropriate to define problem as an instance of indeterminacy and in so doing one might feel that he has completed the difficult task of telling his students what is meant by "problem."

A SUGGESTED RESOLUTION

Describing a problem as an instance of indeterminacy is indeterminate. In the experience of the author there seem to be three categories of indeterminacy the knowledge of which assists students in understanding what is meant by a problem. The first category is one in which the indeterminacy centers around the items, things, variables, that make up the complex with which they are dealing. This category of problem might be labeled as what-variables-exist-problems. Probably the topic most extensively researched in this category is intelligence. Of what is intelligence comprised? Many factor analytic hours have been spent in search of that answer. The historical methodology seems also applicable. Historians frequently seek information as to what is involved in an event.

The second category of problems proposed here is included in the question, what is the nature of a specified variable? It is not enough to state that intelligence involves a verbal factor, we must proceed to the identification of the nature of that factor. This includes its definition, and the examination of the range in which that verbal factor is displayed by individuals. Work of this sort defines what is meant by the What-is-the-nature-of-the-variable-problems.

The final category is one which seeks the answer to the question of cause and effect. If a change is induced in variable A, what will be its impact on variable B?

These three categories of problems have a hierarchial arrangement. If our body of knowledge is unable to produce answers to

the what-variables-exist question, we have identified a problem and the locus for needed research. If that question can be answered positively but the body of knowledge fails to provide the answer to the What-is-the-nature-of-the-variable question, again the problem has been identified and focus of needed research is pinpointed. Finally, given the answer to the two previous questions, yet failure in the literature to answer the cause-and-effect questions, the problem is identified and the nature of research necessary for its resolution is suggested. It must be emphasized that although this hierarchial arrangement appears to exist, at any point in time, findings and insights may cause us to drop back on the hierarchy. That is, in an effort to resolve a cause and effect question, a researcher may uncover the need for knowledge about either the existence or nature of an additional variable.

It is proposed that a problem can be defined as one of four instances of indeterminacy: anomaly, unverified facts, uncharted areas, or conflicting evidence. Further, it appears that in each category three levels of problem may be identified:

1. What variables are involved?
2. What is the nature of these variables?
3. What is their cause and effect relationship?

Using these two means of classification, a grid can be structured as displayed in Figure 1. It is believed that a student can be aided in the identification and delineation of a problem through the use of this grid. To do so he would first examine the area in which he is interested to determine whether an anomaly, unverified fact, uncharted area, or conflicting evidence exists. Having so examined the area and settled on one of the types of indeterminacy, he should move then to the answer of the questions which label the columns in the grid. At the point where he is unable to move further, he has identified a problem and delineated its character.

Type of Indeterminacy	What variables are involved?	What is the natu.e of these variables?	What is the cause & effect relationship?
Anomaly			
Unverified Fact			
Uncharted Area			
Conflicting Evidence			

Fig. 1: A Classification System for Research Problems

It is expected that some problems will be classified as more than one of the four instances of indeterminacy. In such cases it should be suspected that numerous problems exist. The researcher is here advised to examine the statements he makes as the basis for labeling his problem as an anomaly, uncharted area, etc. In this examination he may be able to discern differences which will separate the several problems which have to this point appeared as a single problem.

Although this procedure sounds simple in words, it is not simple in process. In the past few years several techniques have developed which can be used as tools in the delineation of a problem. The remainder of this report is spent in describing these tools and discussing their application.

PROBLEM DELINEATION TECHNIQUE

As aids in the complex process of delineating a problem, three techniques have evolved. The Integrative Theonomy developed by Ray Dethy and William Gephart, Facet Design and Analysis developed by Louis Guttman and described by Philip Runkel, and Componential Analysis developed in the field of anthropology and described by Ward Goodenough. The three techniques have a considerable amount of overlap which should become apparent as they are described. This overlap is of interest since three distinct fields are represented. The first comes from educationists, the second, sociologists, and the third, anthropologists.

THE INTEGRATIVE THEONOMY*

This technique evolved as an effort was being made to put boundaries around a complex area. The best short description of the Inegrative Theonomy technique would be the phrase, a conceptual correlation matrix. A correlation matrix, as you well know, is a grid which has an identical number of rows and columns *and* has identical labels for the rows and columns. An Integrative Theonomy has those same properties. It differs in the content within the cells of the matrix. In a correlation table the cells consist of numbers ranging from +1 to -1. In an Integrative Theonomy the cells contain conceptual statements.

The application of the technique involves the following procedural steps. First, a search is made of the literature in an area of interest to identify items or variables which provide its

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*This technique underlies the outline for *Educational Administration: Selected Readings.* Eds. Walter Hack, John Ramseyer, William Gephart, and James Heck. Boston: Allyn and Bacon, 1965. The technique was not however described in that publication. It has also been employed as the underlying structure of a course in educational administration taught by Ray Dethy at Northeastern University.

basic structure. Those items make up the labels for the rows *and* columns of a grid. Development of such a grid has a row of cells that progress diagonally from the upper left hand corner to the lower right hand corner which have a common label. That is, the label on the row and on the column are identical. This set of diagonal cells serves a specific purpose in the Integrative Theonomy. It is the base from which further analysis stems. Those cells are the holding point for two things: (1) The definition of the term which labels that row and column; and (2) A listing of the elements subsumed within the definition.

Once this definition and either the taxonomic or categorical listing is completed the individual is ready to move off those diagonal cells. As in a correlation table, those cells below and to the left of the diagonal are identical to those above and to the right. Completing both sets would be unnecessary. It should also be pointed out that the cells off the diagonal are interactions between two variables. Every cell from that point on is an instance in which to terms with precise definitions can be identified as the label. The basic question asked in each cell is, is there a relationship between these two terms? If so, what is it?

In dealing with a specific content area, many of these cells will be filled readily. Some of them, however, will remain blank. Blank cells provide possible problem identification. Does something, some relationship of which we are now unaware, exist at this point?

By examining an area in this manner the individual is forced to focus on the interactions. How do pairs of items relate? From studies in the social sciences we are fairly sure that multiple interactions play a part in many areas. It is suggested therefore, that an examination of the multiple interactions also be undertaken after the pairs are described. The inability to describe an interaction is an instance of *indeterminacy*.

This approach enables two kinds of problem delineation activities. The first results from an instance in which the literature provides information that an interaction exists but its delineation

is incomplete. The second type of problem occurs in those instances in which the literature fails to provide any information at all about a cell. In this case we would find no suggestion in the literature that such a relationship exists. However, given the structuring in the grid, a relationship is suspected. That activity would lead the individual to research which would confirm or disconfirm the possible interrelation.

The author used this technique at one point in the examination of the secondary school curriculum. Figure 2 shows the grid that was developed at the start of that application. The elements of the curriculum were identified as labels for the rows and the columns. The diagonal cells in which common labeling occurs were structured with the definition of the element of the curriculum focused. The goal in this effort was to determine overlap in the secondary school curriculum; instances in which the same concept is taught but from differing vantage points. Where do educational efforts overlap?

The full treatment of the curriculum study will not be explicated here as that would require more space than available. It should suffice to make one or two examples. A basic concept in the area of mathematics is the scalor applications of numbers. A basic concept in science is the establishment of orderly descriptions of the physical phenomena surrounding the individual. The second cell in the top row focuses on the interaction in the curriculum between science and mathematics. The two concepts listed above have a definite interrelationship. In the establishment of orderly descriptions of physical phenomena an application exists for the mathematic concept.

The first cell in the third row would be the interaction between science and the social sciences. Again, basic concepts are available which display this interaction. In social sciences the effects of the physical surrounding on the social activities would be included. The interaction between these two provides instances of complementarity.

In summary then, the Integrative Theonomy is a conceptual correlation technique focusing on the definition and delineation

	Science	Mathematics	Social Science	Language	Fine Arts	Practical Arts	Physical Education
Science	a. Definition b. Concepts						
Mathematics	Science & Math Interactions	a. Definition b. Concepts					
Social Sciences	Science & SS Interactions	Math & SS Interactions	a. Definition b. Concepts				
Language	Science & Lang Interactions	Math & Lang Interactions	SS & Lang Interactions	a. Definition b. Concepts			
Fine Arts	Science & FA Interactions	Math & FA Interactions	SS & FA Interactions	Lang & FA Interactions	a. Definition b. Concepts		
Practical Arts	Science & PA Interactions	Math & PA Interactions	SS & PA Interactions	Lang & PA Interactions	FA & PA Interactions	a. Definition b. Concepts	
Physical Education	Science & PE Interactions	Math & PE Interactions	SS & PE Interactions	Lang & PE Interactions	FA & PE Interactions	PA & PE Interactions	a. Definition b. Concepts

FIGURE 2: The Integrative Theonomy Applied to the Secondary School Curriculum

of elements which comprise an area *and* on the possible interrelationships among those elements. This author has found it a useful technique in conceptualizing activities about complex areas *and* in the identification of elements of such areas that are unknown.

FACET ANALYSIS AND DESIGN

Louis Guttman, a sociologist, has asserted that it is possible in advance of the collection of data to evolve a structural theory for observing interrelationships among known and unknown aspects of the theory. The technique he employs is called Facet Analysis and Design. Runkel (Runkel, 1965) analyzes Guttman's suggestions to show: (1) how the technique can be employed; and (2) that through its employment a more complete understanding of an area being studied can evolve.

Facet Analysis and Design involves six steps:

1. The selection of elements known or suspected to comprise the problem area under scrutiny.
2. The precise definition of those elements.
3. The examination of those elements for common but variable aspects (called facets).
4. The determination of the levels of those common aspects that can be seen in the problem (where possible these levels should be valid conceptual scales).
5. Listing the universe of profiles that exist through all possible combinations of the facet levels.
6. Determination of the relationships among the universe of profiles.

This procedure has recently been employed by the author in the examination of research methodologies (Gephart, 1969). Part of that presentation will be used to exemplify Facet Analysis and Design.

The literature on research methods repeatedly refers to four general subcategories: historical, descriptive, experimental, and

quasi-experimental methodologies. In the work cited above an effort was made to achieve a precise yet acceptable definition of these four observable categories from the available literature on the research process. Those definitions are:

1. Historical Method. The use of observations recorded by others to interpret what happened to whom.
2. Descriptive Method. The use of specifically designed measuring instruments for the collection of data to depict the manner in which population is distributed on a variable or variables.
3. Experimental Method. The administration of specified treatments to a population or a sample of a population and the valid and reliable measure of the effects of those treatments.
4. Quasi-experimental Method. The administration of treatments to intact groups and the valid and reliable measure of effects of those treatments.

Given the acceptance of those definitions (and I recognize that as a major indulgence on your part but one that is necessary for the example) three items can be seen which are common to, yet variable in, the four methods. Those three items or facets, to use Guttman's terms, are: unit representativeness, treatment administration, and measurement fidelity. In the first of these the focus is on the degree to which those units studied represent a specified population. The historian is concerned about who or what is included in the phenomenon he studies. He has to establish the nature of the group on which he has obtained valid records and the nature of the population represented by this sample. The descriptive researcher, with his objective of depicting, has to ascertain the boundaries of the population he studies and the degree to which those on which he has or gets measures represents this population. The experimenter must also be concerned about the population and sample representativeness because generalizations about cause and effect require a population referent. The quasi-experimenter is no less concerned about the population. Granted, he works in an arena in which he is denied direct control over representativeness. But he works in

that natural setting because he wants to know about the effects of variables in that setting. Therefore, his inability to representatively select a sample and to assign it to a treatment is not evidence of a lack of concern, but rather evidence of his concern for reality.

Similarly, the four methods involve treatments. This is an obvious factor in the experiment and the quasi-experiment. Although less obvious, it is part of historical and descriptive methods. The historian is interested in either determining the nature of a treatment experienced by a group or in the effects of that treatment. The descriptive method focuses on a group for a reason. They have had an apparently common set of experiences which make them an interesting group for description.

Measurement is also an obvious facet of these four methods. In each case, the investigator measures either through the use of already existing observations or through the generation of data.

Given the acceptance of these statements, three facets are clear: representativeness of the units studied, content of the treatment experienced, and measurement fidelity. Are there other items common to the four method definitions? Yes, each one either clearly states or implies that it is an effort to learn something. This is not considered as a facet, however, as it is a constant in all methods rather than something that exists at different levels.

The next activity in the Facet Design Technique is the determination of the levels on the various facets. Both Guttman and Runkel clearly display the advantage of looking for levels that are at least conceptual scales. They imply that the levels might be determined by further examination of the definitions used to generate the facets. In the re-examination of the four definitions above, unit representativeness has at least two characteristics. In experimental and descriptive studies the investigator controls the representativeness of the units. On the other hand, the quasi-experimentalist and the historian do not have initial control. There seems to be a scale underlying these two

levels. If the item is under his control, the investigator can be expected to produce greater strength of generalization. If it is not in his control, conclusions must be tempered with the possibility that undisclosed uniqueness may cause the unit studied to be different from the population to which generalizations are to be made. The controlled level is assumed to be more valuable.

The same pair of levels exists in the measurement fidelity and treatment facets. In the former the historian lacks initial control. He uses observations recorded by others as his measures. The three other methodologies are instances in which the investigator decides what and how records should be made. In the treatment facet the historian and descriptive researcher are in a non-control situation. They deal with units that have experienced a treatment, the elements of which they cannot describe with surety. The experimenter and the quasi-experimenter on the other hand carefully structure the experience of the units. In both of these sets of levels the *non-control* case conceptually seems less productive of truth about an unknown than does the control. Thus, we have identified three facets each of which can be analyzed into two levels, controlled or not controlled by the investigator. (In another effort the author and Bruce Bartos have developed ordinal scales for each of these facets. For the sake of this example, however, only the ends of the scales are discussed here.)

Such an analysis enables us to return to the original set of known elements and profile them, as shown in Figure 3. That profiling is effected by the assignment of the subscript 1 in cases of non-control and the subscript 2 in cases of control. Thus, the historical method would be profiled as $m_1r_1t_1$ and would be described as an inquiry method in which all three facets are orignially not in the control of the investigator. Descriptive methodology would be profiled as $m_2r_2t_1$. In this case, one has control over measurement and representativeness but not over treatment.

Research Method	Measurement Fidelity	Representativeness of Units	Treatment Control
Historical	m_1	r_1	t_1
Descriptive	m_2	r_2	t_1
Quasi-experimental	m_2	r_1	t_2
Experimental	m_2	r_2	t_2

Figure 3: Profiles of Established Research Methods

An examination of these profiles leads to the conclusion that there are four profile sets. One set has all control level facets notation (the experimental method). Another has all non-control level facet notation (historical method). Between these extremes is a set that has two facets at the control level and one at the non-control. There is a third possible profile that becomes discernible in this set $m_1r_2t_2$. This would be an inquiry method that involves careful control over treatment and representativeness facets but in a situation that does not permit control over measurement. Such a study might be labeled an unobtrusive-measurement-experiment.

Such a method is beginning to be seen in our literature. Elements of it can be seen in Baker and Gump's ecological psychology studies, Guba's aexperimental methodology paper, and in the text entitled *Unobtrusive Measures* by Webb, Campbell, Schwartz, and Sechrest.

One more category of profiles exists. It includes situations with two facets that are not in the researcher's control and one facet that is. The three possible profiles would be: $m_2r_1t_1$, $m_1r_2t_1$, and $m_1r_1t_2$. This brings us to a total of eight profiles, all that could possibly exist if a system consists of three facets each of which has two levels. Such a system leads to a 2x2x2 matrix, and a total of eight separate categories. The figure below lists the complete set of inquiry methods, the level of control in each of the three facets, and, where possible, supplies a descriptive name for the strategy.

Research Method	Facets on Levels of Control: Measurement Fidelity	Representativeness of Units	Treatment Control
A. Historical	m_1	r_1	t_1
B.	m_2	r_1	t_1
C. Case Study	m_1	r_2	t_1
D.	m_1	r_1	t_2
E. Descriptive	m_2	r_2	t_1
F. Quasi-experimental	m_2	r_1	t_2
G. Unobtrusive-measure experimental	m_1	r_2	t_2
H. Experimental	m_2	r_2	t_2

Figure 4: Eight General Inquiry Methods

The two unnamed methods, method B and D, do have counterparts in the literature. Method B is one in which measurement fidelity is under the control of the investigator, but representativeness and treatments are not. This profile seems to be indicative of instrument standardization studies. Pilot studies conducted prior to an experiment very often fit the characteristics of Method D. In such cases instructed observations are made on intact groups after the administration of some treatment.

Again it is recognized that lengthy debate can range about the eight methods identified in Figure 4. Such discussion is welcomed. At this point however, the focus is on the application of the Facet Analysis and Design technique. Thus, the debate shall be deferred. It is emphasized though, that through the technque a categorization system has been created which accounts for the items currently accepted in the literature and suggests several others. One of the suggested items accounts for a research methodology (case study) that, although recognized, has not been acceptable within the categorization use to date. Another of the suggested items can readily be seen as the label for a growing methodology. This ability, to help one see relationships of items which have not in the past been logically structured, is evidence of the technique's effectiveness.

IS

Facet Analysis and Design is a technique through which definitions of known elements which comprise a problem area can be used in the delineation of common but variable facets. These facets and their underlying scales make possible the profiling of the number of elements which would comprise the problem area.

COMPONENTIAL ANALYSIS

Componential Analysis is described by Ward Goodenough as "a method of descriptive sematics" which "deals with signification with definitive attributes and the ways in which they combine and are mutually ordered." (Goodenough, 1967) It is a technique found useful by anthropologists in the delineation of a domain and the variation within the domain. It involves two steps. First, a record is made of the specific concepts which informants say an expression may denote. Second, a set of definitive attributes about those concepts is made. This set must predict what informants say may and may not be denoted by the expression. This latter step is completed through two activities: (1) inspecting the concepts for common attributes; and (2) contrasting the set of concepts with those derived from other expressions.

An example of Componential Analysis of the term "aunt" is used by Goodenough to clarify these activities. In step one individuals are asked to tell what in their experience the term "aunt" refers to. In such an effort might produce phrases indicating my mother's sister-in-law, etc. Next he is asked for instances that are not "aunt." An examination of these lists leads Goodenough to the assertion that aunt yields "any relative to blood or marriage who is simultaneously: (i) female, (ii) removed from the individual by two degrees of genealogical distance, (iii) not a lineral removal, (iv) in a senior generation, and (v) not connected by marital tie in other than the senior generation of the relationship."

These five items make up the set of definitive attributes descriptive of the term, "aunt." They were created by inspecting

various phrases people list when asked to tell who their aunt is. The check of that list of attributes can be made against the list of other similar terms, for example, "uncle." The very first attribute in this case differs, consequently femaleness is an attribute characteristic of aunts, and not characteristic of uncles. The same can be done for each of the items in the set of attributes. Upon satisfaction that the set of attributes is complete, that is, all of the means of referring to aunt are included by the attributes and all of the terms used in describing other expressions are excluded, one has identified the components and has completed the first aspect of Componential Analysis.

Two points are emphasized by Goodenough. First, if variation is made on one or more of the components a different relationship is established. Thus, this same set of five variables serve in delineating multiple terms such as, aunt, uncle, nephew, niece, great aunt, etc. The five attributes so identified seem to be the componential base for the construct, "relationship." To complete the Componential Analysis of that universe we must move to the variance that can be accepted in each of the elements. For example, element (i) deals with sex, consisting of the two categories, male and female. Element (ii) genealogical distance would encompass same generation, one generation removed, two generations removed, etc. The same type of analysis is continued for each of the elements. When this is completed the componential base for the domain, "relationships," is in hand.

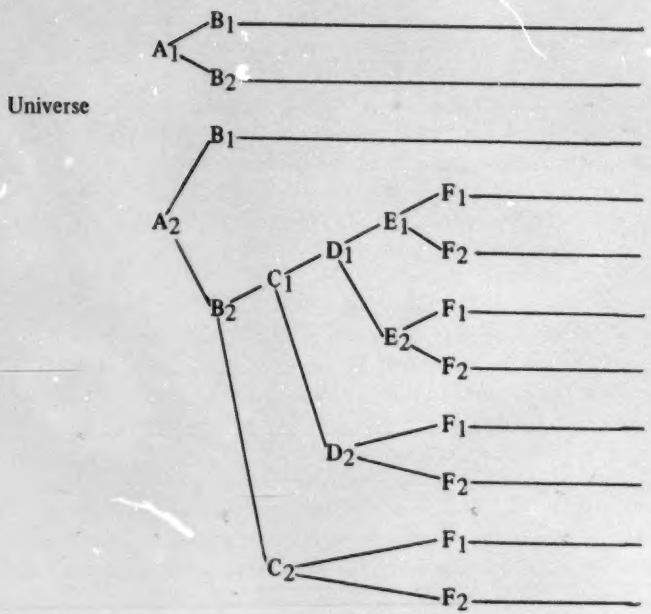
The second point that needs to be called to attention is that of nesting. In the relationship example it can readily be seen that the terms "father" and "mother" nest in the term "parent." In a different example, "collie" is nested within the term "dog," which is nested within the term "mammal," etc. Nesting then is a concept appropriate within componential analysis, a point that is readily acceptable. A more important understanding is that nesting denotes differentiation in contrast level. The level of contrasting in dealing with father and mother includes an item not included at the level of contrast in distinguishing between parent and non-parent. That item is sex.

In his article Goodenough applies the technique to the kinship ties in another culture. In that application eleven elements are identified as the componential base for the domain. A schematic representation of that analysis is presented in Figure 3. It is interesting to note that this arrangement is an unbalanced system. Experiences with the Facet Analysis and Design and Integrative Theonomy techniques lead to questions about the incomplete elements in the representation.

PROBLEM DELINEATION IN THE TRAINING OF RESEARCHERS

The discussion of the meaning of the term "problem" and the three techniques described above seem to have two applications in our focus on research training. First, they could be accepted as content which might be taught to the researcher-to-be. Second, we might use them to examine the area, research instruction. Although the first of these is interesting, the latter seems more germane for a group interested in improving instruction on educational research. In the use of these approaches it is believed that two ends can be served. If the problem identification grid presented at the outset of this paper is of value it should help us pinpoint problems in the training of researchers. And, if the three problem delineation techniques are of value, their use ought to facilitate movement to careful empirical studies of the research instruction process. The discussion which follows is not based on work in which these techniques have been applied to research instruction. Results of their use of other problems, however, merit their consideration.

If we apply these procedures we would first ask ourselves, what is the nature of the concern? The answer is immediately in mind. We are trying to improve the means by which we help people master concepts about and skills needed in educational research. But that is a rather gross area. Its size does not automatically make it a research problem. Is there some indeterminacy in what we are trying to do? The literature seems to say there is. We are unable to educate a sufficient quantity of



A - Similarity of Generation (A_1= Same; A_2= Different)
B - Closeness of relationship (B_1= Closest possible; B_2= Not close)
C - Number of generations between (C_1= 1 generation apart; C_2= 2 generations apart)
D - Similarity of sex of senior party & of living parent of junior party (D_1= Same sex; D_2= Different sex)
E - Relative age of senior party & of living parent of junior party (E_1= Senior party older; E_2= Senior party younger)
F - Sex of senior party (F_1= Male; F_2= Female)

FIG. 5 COMPONENTIAL ANALYSIS OF KINSHIP TIES*

*W. Goodenough, SCIENCE 156: p. 1207; 1967

skilled personnel and the quality of those educated is below what is desired.

What type of indeterminacy is that? Is it an anomaly, an uncharted area? It is an instance of conflicting evidence or unverified fact? Arguments can be presented which would indicate that several of these categories are appropriate. It is an anomaly. Highly reputable people have devoted a lot of time and effort to the training of researchers, yet effective means for that task have not been identified. These same skilled people have solved other complex problems.

The problem can also be described as an uncharted area in that a search of the literature fails to produce evidence which would enable assertive statements as to its nature. Lists of courses offered and hortative articles which describe what ought to be taught can be identified. Empirical evidence, however, is lacking.

The problem can also be described as one of unverified fact. It does appear that the profession has accepted four general course work areas as the content of research training. These include courses in: (1) introduction to research; (2) measurement; (3) statistical analysis, and (4) advanced design. In recent years a focus has been made on practicum activities. Empirical evidence which would confirm the inclusion or exclusion of these elements is not available.

The inability to definitively categorize the problem leads to the suspicion that a number of problems exist. Given the ways we have looked at the problem, it is an anomaly AND an uncharted area AND unverified fact. What is it about these ways of looking that lead to multiple categorization? Is it possible that the multiple categorization is a result of focusing simultaneously on different aspects of the problem? What is it about the problem that leads us to label it an anomaly? An uncharted area? An instance of unverified fact? Are the things that lead to the first label different from those leading to the other two? Is there any sequentiality in these differences? Is it possible that elimination of the things that lead to the label "unverified fact" is required

before the anomalous aspects of the problem can be resolved? Is the other order likely?

One can list quite a number of questions at this point and they can be responded to. However, the response ought to be based on evidence and logic, not logic alone. The assistance of this audience is generating that evidence is desired.

The list of questions presents a difficulty. Each of them is interesting. But are they related? Are some of them at a more basic level than others. The listing above fails to provide cues in this direction. The second aspect of the problem delineation grid presented in this paper was a hierarchy of questions. What variables exist? What is their nature? And, what is their cause-and-effect relationship? It is believed that this hierarchy can assist in ordering the questions we can raise about the research training problem.

What variables led us to classify the problem as an anomaly? What is the nature of these variables? Are there cause and effect relationships among them? The answers to these questions should lead us to the point of indeterminacy that made that label, an anomaly, appropriate. If this same effort is made in respect to the other two problem labels we ought to be able to pinpoint the basic problem and to fix on a priority of research efforts necessary to resolve the difficulty.

When the problem (or problems) in research training is identified, beneficial use of the three delineation techniques is seen. For example, it might be decided that the basic problem in research instruction is inadequate knowledge about the nature of the research process. Given such a decision, Componential Analysis, Integrative Theonomy, or Facet Analysis and Design procedures could be utilized to determine the nature of the elements now known to be involved. The elements not now known to logically constitute the remainder of the domain the research process, and the interrelationships that might be suspected. It might be decided that the basic problem is, deficiencies in instruction strategies. Again, the three, techniques seem applicable.

These two problem possibilities are selected as examples for a reason. It has been recognized in several other education areas recently that progress requires the development of clarity in discrimination between the subject taught and the methods for that instruction. Asahel Woodruff (Woodruff, 1968) has helped draw this distinction. He argues that a behavior, which is an objective of an educational system, consists of conditioned and cognitive aspects *and* involves language and data elements. This model can be applied to objectives in research training. There appear to be conditioned aspects of research activity. That is, when an individual encounters an instance of indeterminancy, as a researcher he ought to feel the need for empirical evidence for its resolution. At the same time, there are cognitive aspects: he has to know the how and whys of data generation and analysis.

Woodruff indicates that behaviors can be placed on a continuum of predictability. At one end are those behaviors which are extremely consistent and at the other end are those behaviors which are extremely consistent and at the other end those which are quite variable. Examples of these extremes would be:

1. If a hand is placed on a hot stove the behavior can be predicted with a fair degree of accuracy. The hand will be withdrawn.
2. If individuals are placed in positions in which behavior involves the resolution of an educational problem, variation from person to person will be readily observable.

In Woodruff's model presented below this combination of cognitive and conditioned aspects of a given behavior is displayed.

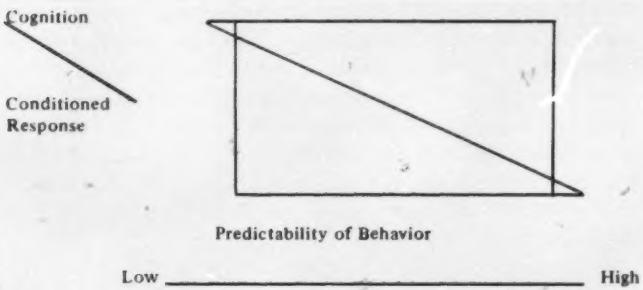


Figure 6: The Cognitive and Conditioning Aspects of Behaviors

The space below the diagonal line includes the conditioned response aspects of a given behavior. The space above the diagonal line includes the conceptual component of that behavior. If a behavior is located at the extreme left of the model, it is interpreted as almost an entirely conditioned response and extremely predictable. The opposite extreme would be a behavior that is almost totally conceptual. Any given behavior held as an educational objective exists somewhere within the vertical lines of the model as it has both cognitive and conditioned response aspects.

Teaching, which has as its objective the achievement of such a behavior, has to take into account two more items. These include first, the language or expressive nature of the behavior. The second element (also described by Woodruff) is the data necessary for engaging in the behavior. Data in this respect are interpreted either as numbers, items, things, or materials necessary to engage in the activity. The concentration here, for the teacher at least, is the means of assisting the student to identify the necessary materials or data or the knowledge of the means of creating data necessary for a behavior. Thus, the teaching of a behavior recognized as an aspect of the research process involves the establishment of conditions whereby:

1. The cognitive aspects of the behavior as mastered by the learner.
2. The conditioned responses are developed.
3. The expressive language of the behavior is mastered by the student.
4. The data required for participation in that behavior are either available or generatable by the learner.

Those things done by the teacher to establish these four conditions are the items intended by the term "the teaching of research." They ought to be differentiated from their product, research behaviors, if we are to resolve our instructional problems.

SUMMARY

This presentation has asserted that the term "problem" is poorly defined in the literature on the research process. It has explored the possibility of delineating a definition for that term and three techniques in the literature which provide means for delineation of problems. Finally, it attempted to suggest that these means have application to the problem of the teaching of researchers. It is recognized that this latter area is the weakest aspect of the presentation as it asserts applicability primarily on the basis of unrelated applications. The application of these techniques has been stimulating in other areas. Because of that stimulation it seems probable that they could be helpful in the problems faced in the training of researchers. The assistance of this audience is solicited in making that application and testing their utility.

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